CLAIMS

WHAT IS CLAIMED IS:

1. An accelerated weathering apparatus, comprising:

an enclosure having at least one door for access to a test chamber defined within the enclosure;

a specimen mounting apparatus disposed within the test chamber for supporting specimen holders;

a light source disposed within the test chamber for producing light in the test chamber;

a power source for powering the light source;

a test module removably disposed in a pocket defined in the at least one door for detecting irradiance in the test chamber produced by the light source and generating an irradiance signal representative of the detected irradiance;

a ballast connected to the light source for controlling the amount of power received by the light source from the power source;

a controller connected to the test module and the ballast which controls operation of the ballast by transmitting a ballast control signal, whereby the controller adjusts the ballast control signal in response to the irradiance signal received from the test module in order to maintain a desired irradiance within the test chamber; and

a calibration module for detecting the irradiance in the test chamber in order to generate and display a reference value which represents the detected irradiance, whereby the calibration module interchangeably replaces the test module in the pocket to detect the irradiance in the test chamber and display the reference value on the calibration module which is inputted to the controller for adjusting the ballast control signal.

2. The apparatus as recited in claim 1, wherein the light source includes a plurality of lamps.

3. The apparatus as recited in claim 1, wherein the pocket is formed in the at least one door such that a recess is provided on the exterior surface of the at least one door so that the test module and calibration module may each be interchangeably, removably disposed within the pocket when the at least one door is in a closed position.

4. The apparatus as recited in claim 1, wherein the light source is selected from the group of lamps that generate ultraviolet light in the UV-A, UV-B, and UV-C ranges.

5. The apparatus as recited in claim 1, wherein the calibration module includes at least two internal calibration routines which allow calibration of at least two different types of ultraviolet light while using the same calibration module.

6. The apparatus as recited in claim 1, wherein the test module further includes a plug which interfaces with a receptacle disposed in the pocket in order to connect the controller and the test module such that the controller is automatically connected to the test module when the test module is disposed within the pocket.

7. The apparatus as recited in claim 1, wherein the test module includes at least one test sensor of an optical photodiode type.

8. The apparatus as recited in claim 1, wherein the calibration module includes a reference sensor of an optical photodiode type.

9. The apparatus as recited in claim 9, wherein the test sensor has a liner slope of responsivity in the ultraviolet range.

10. The apparatus as recited in claim 1, wherein the controller includes a processing unit and memory that stores programming instructions, that, when read by the processing unit, causes the controller to function to: receive a set-point input for the desired irradiance signal; and begin a testing procedure including the steps of: outputting a ballast control signal to the ballast based upon the set-point; receiving the irradiance signal input from the test module; adjusting the ballast control signal based upon gain between the set-point and the irradiance signal; outputting an adjusted ballast control signal; and repeating testing procedure steps for a desired period of time.

11. The apparatus as recited in claim 1, further including a temperature sensor connected to the controller for monitoring the temperature within the test chamber, generating a temperature signal, and transmitting the temperature signal to the controller for adjusting the heater control signal in order to maintain the desired temperature within the test chamber.

12. The apparatus as recited in claim 1, further including a temperature sensor connected to the controller for monitoring the temperature within the test chamber, generating a temperature signal, and transmitting the temperature signal to the controller for adjusting the ballast control signal in order to maintain the desired irradiance within the test chamber.

13. The apparatus as recited in claim 1, wherein the test module amplifies and filters the irradiance signal to reduce frequency noise.

14. The apparatus as recited in claim 13, wherein the reduction in frequency noise is achieved by converting a high impedance signal to a low impedance signal with gain.

15. An accelerated weathering apparatus, comprising:

an enclosure having doors for accessing a test chamber defined within the enclosure;

a specimen mounting apparatus disposed within the test chamber for supporting specimen holders;

an array of light sources disposed within the test chamber for producing light within the test chamber;

a power source for powering the array of light sources; and

a plurality of automatically adjustable control channels for sequentially controlling output of the array of light sources, each of the control channels controlling an output of at least one of the light sources, the plurality of control channels including a plurality of test modules removably disposed within pockets defined in the doors and arranged to detect different spatial areas of the specimen mounting apparatus.

16. The apparatus as recited in claim 15, wherein each control channel further includes:

a ballast connected to at least one of the light sources for controlling the amount of power received by the at least one of the light sources from the power source;

a controller connected to the test modules and the ballast for generating a ballast control signal which controls operation of the ballast;

a test sensor included with each of the plurality of test modules, the test sensor inserted into an aperture formed in the pocket at a location corresponding to the at least one light source, to detect irradiance in the test chamber produced by the at least one light source, and for generating an irradiance signal representative of the detected irradiance;

a transmitting device disposed within the test module connected to the test sensor and the controller for transmitting the irradiance signal to the controller such that the controller may adjust the ballast control signal to maintain the irradiance signal at a desired set point.

17. The apparatus as recited in claim 15, wherein there are first and second specimen supporting walls and there are first and second rows of light sources, each row having four lamps.

18. The apparatus as recited in claim 15, wherein the plurality of test modules includes four test modules disposed in the pockets such that each one of the four test modules is disposed to substantially select irradiance from two adjacent lamps.

19. The apparatus as recited in claim 15, wherein the plurality of control channels including includes four separately adjustable control channels.

20. The apparatus as recited in claim 15, further including a calibration module including a reference sensor designed to detect the irradiance inside the test chamber and to generate a reference value representative of the detected irradiance and a reference value display connected to the reference sensor for displaying the reference value which is inputted to the control channels to adjust the output of the array of light sources.

21. The apparatus as recited in claim 16, further including a temperature sensor connected to the controller for monitoring temperature within the test chamber, generating a temperature signal, and transmitting the temperature signal to the controller for adjusting the ballast control signal in order to maintain a desired irradiance within the test chamber.

22. The apparatus as recited in claim 16, further including a temperature sensor connected to the controller for monitoring the temperature within the test chamber, generating a temperature signal, and transmitting the temperature signal to the controller for adjusting the heater control signal in order to maintain the desired temperature within the test chamber.

23. The apparatus as recited in claim 15, wherein the plurality of test modules amplifies and filters the irradiance signal to reduce frequency noise.

24. The apparatus as recited in claim 23, wherein the reduction in frequency noise is achieved by converting a high impedance signal to a low impedance signal with gain.

25. The apparatus as recited in claim 16, wherein the controller includes a processing unit and memory that stores programming instructions, that, when read by the processing unit, causes the controller to function to: receive a set-point input for a desired irradiance signal; and begin a testing procedure including the steps of:

outputting a ballast control signal to the ballast based upon the set-point; receiving the irradiance signal input from the test module;

adjusting the ballast control signal based upon gain between the set-point and the irradiance signal;

outputting an adjusted ballast control signal; and

repeating testing procedure steps for a desired period of time.

26. The apparatus as recited in claim 25, wherein the controller includes further programming instructions, that, when read by the processing unit, causes the controller to function to: select one of the control channels for calibration; and begin a calibration procedure including the steps of:

disconnecting the test module associated with the selected control channel;

connecting a calibration module including a reference sensor with the selected control channel;

detecting with the reference sensor irradiance existing in the test chamber substantially due to irradiance produced by the light source associated with the selected control channel in order to generate a reference value;

displaying the reference value on a display included with the calibration module;

repeating the above steps for each control channel;

inputting the reference values into the controller;

comparing the reference value associated with each control channel with a set point associated with each control channel; and

adjusting a gain for each control channel in order to calibrate the output of the light source associated with each control channel.

27. The apparatus as recited in claim 26, wherein the calibration procedure further includes the steps of:

detecting with the calibration module for the group of lamps which generate ultraviolet light in the UV-A, UV-B, or UV-C ranges; and

communicating automatically the detected lamp to the controller.

28. An accelerated weathering apparatus, comprising:

an enclosure having at least one door for access to a test chamber defined within the enclosure;

a light source disposed within the test chamber for producing light in the test chamber;

a power source for powering the light source;

a ballast connected to the light source and the power source for controlling the amount of output by the light source from the power source, the ballast including circuitry which controls start-up of the light source such that a low voltage is applied to the light source for a desired period of time in order to warm the light source before igniting whereby shock to the light source is minimized and useful life of the light source is prolonged; and

a controller connected to a test module and the ballast which controls operation of the ballast by transmitting a ballast control signal, whereby the controller adjusts the ballast control signal in response to an irradiance signal received from the test module in order to maintain a desired irradiance within the test chamber.

29. The apparatus as recited in claim 28, wherein the low voltage is ramped to the light source until reaching operating voltage.

30. The apparatus as recited in claim 28, further including a temperature sensor connected to the controller for monitoring temperature within the test chamber, generating a temperature signal, and transmitting the temperature signal to the controller for adjusting the ballast control signal in order to maintain the desired irradiance within the test chamber.

31. The apparatus as recited in claim 28, further including a temperature sensor connected to the controller for monitoring the temperature

within the test chamber, generating a temperature signal, and transmitting the temperature signal to the controller for adjusting the heater control signal in order to maintain the desired temperature within the test chamber.

32. The apparatus as recited in claim 28, wherein the controller monitors the irradiance signal and adjusts the ballast control signal in response thereto in order to maintain the desired irradiance within the test chamber.

33. The apparatus as recited in claim 28, wherein the desired period of time is at least approximately 1.5 seconds.

34. The apparatus as recited in claim 28, wherein the low voltage is approximately in the range of 2 to 5 volts.

35. A method of accelerated weather testing of specimens in a testing apparatus having a test chamber, a specimen mounting apparatus, light sources powered by a power source controlled by a ballast, a plurality of automatically adjustable control channels for sequentially controlling output of the light sources, each of the channels controlling an output of at least one of the light sources, each channel having a test module including a test sensor to detect the irradiance inside the test chamber, the method comprising the steps of:

detecting with one of the test sensors irradiance existing in the test chamber substantially due to irradiance produced by the light sources associated with the control channel with which the light source is associated, in order to generate an irradiance signal;

transmitting the irradiance signal detected by the test sensor to a controller in the control channel;

comparing the irradiance signal with a set-point value to determine if they are equal;

adjusting a ballast control signal to the ballast associated with control channel so that the output of the light source is adjusted;

repeating the above steps until the ballast control signal associated with each control channel has been adjusted thereby defining a cycle;

repeating the above steps for a desired number of cycles;

selecting one of the control channels for calibration;

disconnecting the test module associated with the selected control channel;

connecting a calibration module including a reference sensor with the selected control channel;

detecting with the reference sensor irradiance existing in the test chamber substantially due to irradiance produced by the light source associated with the selected control channel in order to generate a reference value;

displaying the reference value on a display included with the calibration module;

repeating the disconnecting, connecting, detecting and displaying steps immediately above for each control channel;

inputting the reference values into the controller;

comparing the reference values with the set point values;

adjusting again for each control channel in order to calibrate the output of the light source associated with each control channel.

36. The method as recited in claim 35, wherein each control channel further includes a temperature sensor connected to the controller for monitoring the temperature within the test chamber, the method further comprising the steps of: generating a temperature signal; and transmitting the temperature to the controller for adjusting the ballast control signal in order to maintain the desired irradiance within the test chamber.

37. The apparatus as recited in claim 35, further including a temperature sensor connected to the controller for monitoring the temperature within the test chamber, generating a temperature signal, and transmitting the temperature signal to the controller for adjusting the heater control signal in order to maintain the desired temperature within the test chamber.

38. The method as recited in claim 35, wherein the method further comprises the steps of: monitoring the current draw of the ballast; and

adjusting the ballast control signal in order to maintain the desired irradiance within the test chamber.

39. A method of accelerated weather testing of specimens in a testing apparatus having a test chamber, a specimen mounting apparatus, light sources powered by a power source controlled by a ballast, a plurality of automatically adjustable control channels for sequentially controlling output of the light sources, each of the channels controlling an output of at least one of the light sources, each channel having a test module including a test sensor to detect the irradiance inside the test chamber, the method comprising the steps of:

controlling start-up of the light sources with circuitry in the ballast which applies a low voltage to the light source for a desired period of time to warm the light source before igniting whereby shock to the light source is minimized and useful life of the light source is prolonged;

detecting with one of the test sensors irradiance existing in the test chamber substantially due to irradiance produced by the light sources associated with the control channel with which the light source is associated, in order to generate an irradiance signal;

transmitting the irradiance signal detected by the test sensor to a controller in the control channel;

comparing the irradiance signal with a set-point value to determine if they are equal;

adjusting a ballast control signal to the ballast associated with control channel based on the gain between the set point value and the irradiance signal so that the output of the light source is adjusted;

repeating the above steps until the ballast control signal associated with each control channel has been adjusted thereby defining a cycle;

repeating the above steps for a desired number of cycles;

selecting one of the control channels for calibration;

disconnecting the test module associated with the selected control channel;

connecting a calibration module including a reference sensor with the selected control channel;

detecting with the reference sensor irradiance existing in the test chamber substantially due to irradiance produced by the light source associated with the selected control channel in order to generate a reference value;

displaying the reference value on a display included with the calibration module;

repeating the disconnecting, connecting, detecting and displaying steps immediately above for each control channel;

inputting the reference values into the controller;

comparing the reference values with the set point values;

adjusting again for each control channel in order to calibrate the output of the light source associated with each control channel.

40. The method as recited in claim 39, wherein the desired period of time is at least approximately 1.5 seconds.

41. The method as recited in claim 39, wherein the low voltage is approximately in the range of 2 to 5 volts.